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Date: 5-11-59

To: J. L. Hult

Memo No.: M-3008

From: A. H. Katz

Subject: RECOMMENDATIONS, FORMAL AND INFORMAL, ON RECONNAISSANCE SATELLITE MATTERS

Copies To: C. P. Bahrman, E. J. Barlow, R. L. Belzer, R. W. Buchheim, M. E. Davies, J. F. Digby, W. B. Graham, B. W. Haydon, E. C. Heffern, L. J. Henderson, J. H. Huntzicker, B. H. Klein, J. E. Loftus, H. P. Lynn, L. B. Rumph, A. J. Wohlstetter, File

Recent disclosures by BMD, in particular by the 117L Office, indicate that they are slowly but none the less surely taking up some of the ideas which we tried (unsuccessfully) to sell them some time ago. This has persuaded me to believe that it might be a useful exercise to wrap up in one memo a listing of as many of these as we can now recall. It may be useful to have this listing both as a matter of record and in a convenient summary. Without trying too hard I have found eight significant items. Not all of these are of equal importance, but certainly all are of considerable interest. I will attempt to summarize the recommendation or suggestion, the action, if any, and the present status.

1. Recoverable Satellite System Certainly our major and formal recommendation in the field of reconnaissance and satellites in the last couple of years has been the recommendation of November 1957 regarding a new family of recoverable reconnaissance satellites. This suggestion has gone through several peculiar phases. Emphasized and expounded at length in RM-2012, in S-72, in the Space Handbook, in lectures, in conferences, at meetings, in briefings, to visitors, to contractors, to the SAB, etc. the main idea that we have been trying to sell has at last been sold. Recoverable satellites are important and complementary to the talk back type system. The psychological insecurity displayed by the 117L Project Office when this idea was first broached, seems to have vanished. They have openly - that is openly within the framework of highly classified meetings - announced that recoverable reconnaissance satellites are part of their program. Of course, we shouldn't feel too happy about this, it is only a partial victory. The major point we were making in late '57 and early '58 was that 50 feet of ground resolution in '59 is infinitely better than five feet in '65. There is a curious tendency among R&D people to settle for something better later over something reasonably good now. We felt strongly at that time, and still feel that the problems awaiting solution by reconnaissance technology will be changing and getting more difficult faster than the reconnaissance techniques will be improving to meet these problems. For example, not only will missile sites be getting harder to find as they get integrated and blended and landscaped but any study of the dynamics of the Soviet conversion to missiles requires several points on the curve, not just a static look at some time in the future. Of course, we take comfort in the fact that recoverability is now a viable notion. We take acute discomfort from the fact that our particular suggestion - for a spin stabilized panoramic camera was not followed. This, however, yields the next item, in logical order.

2. The Use of Panoramic Cameras in Satellites BMD is now talking openly (as defined above) to RAND about the use of panoramic cameras in satellites. The history of this notion is not generally known. The particular type of panoramic camera which BMD is talking about is directly derived from the HYAC camera developed by the late lamented

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Boston University Physical Research Laboratories for use in Program 461L, What is not known is that Davies and I were largely responsible for steering Boston University toward this type of camera for the 461L program.

The history is as follows: In early spring of '57 Davies was doing some preliminary work on what subsequently turned out to be the spin stabilized panoramic camera system of R4-2012. At precisely the same time our large recce group was very interested in and following closely the problems and possibilities of 461L (the balloon reconnaissance system). We were, at that time, in close touch with Walt Levison who headed this project at the Boston Laboratories. The camera which he was considering for application to this problem was a World War II designed Baker camera. which used a spherical shell of film and had a 120° spherical lens associated with it. This was a very elegant and beautiful camera, many years ahead of its time. However, we suggested to Levison that this camera would be difficult to build let alone put into fast production. This was entirely apart from and in addition to the problems of production rate and of weight which would be associated with this kind of a camera. We pointed out to Levison that we had been looking at panoramic cameras, that Fred Willcox (of the Fairchild Camera and Instrument Corporation) had an interesting idea for axially-spun panoramic camera which we thought might be applicable to Walt's problem. In fact we suggested that Levison, a good and old friend of Willcox, call him in and have a discussion with him on the feasibility of panoramic cameras for the balloon system.

As it turned out this is exactly what happened and Levison got enthusiastic about panoramic cameras. Proper and extensive credit is due Levison for the particular camera he finally designed. It performed elegantly and superbly and made what I consider to be the finest aerial photographs ever made from extreme altitudes. Any of the readers of this memo who would like to see a representative sample of such photography are invited to come into my office where I have a few such samples available. As all of the readers of this memo who follow the stock market should know, the Boston University Physical Research Laboratories was taken over lock, stock, barrel and optical bench by the ITEK Corporation (run by Dick Leghorn). It now appears that some of their suggestions for panoramic cameras for satellites are receiving serious consideration and possibly some action by the 117L Office at BMD.

3. Activities on 117L Advisory Committees For the past several years there has been a 117L Advisory Committee, whose initial responsibilities were confined to the field of data handling (Subsystem I) in connection with the satellite program. This committee was originally headed by Duncan Macdonald, subsequently by Harry Goode of the University of Michigan, and now is headed by Bob Shatz (formerly of Cornell Aeronautical Lab). Committee responsibility has been recently broadened by request of General Schriever to include not only data handling - the ground component of the satellite system - but also data collection problems. Many of the recommendations which I have made during the course of these meetings (and of course those which other members of the committee have made) appear as committee recommendations and are not otherwise identified. This is of course exactly as it should be.

One of the more interesting ones of these early recommendations had to do with the importance of and requirement for adequate simulation of the results likely to be

obtained by the satellite. We felt that only by having sufficient material of the approximate quality and amount that would be produced by the satellite could the data handling system and the associated optical equipment with it be adequately tested. This suggestion (which strangely enough had to be argued for quite a while) has been adopted and this form of simulation is an integral and important part of the Ramo-Wooldridge activities under their contract on Subsystem I - the data handling subsystem.

4. The Missile Site Problem Almost exactly three years ago - on May 28, 1956 - we sent a Secret Letter (L-9166) to what subsequently turned out to be BMD (it was then known as Western Development Division). We addressed this letter to the 117L Project Office and in this letter pointed out our interests in the problem of detecting and locating enemy ICBM sites, and the possible utility of reconnaissance satellites for this job. We noted that "the first and inescapable observations that must be made relate to the paucity of relevant data and the urgency and importance of securing data bearing on these two problems." This letter was a result of an earlier conference between several RANDites and several members of the 117L Project Office.

We suggested an active program to secure periodic photographs over test sites, missile bases and especially sites under construction in order to test the conjecture we had made earlier (in a briefing to the SAB in February 1956) that missile sites might be easier detected during the construction phase than after they are finished and integrated with the landscape. This conjecture has been widely repeated, circulated, has now become dogma with no further basis in fact, experiment or data than we had at the time we made this guess. Of course we had nothing whatsoever to go on except intuition.

We suggested that large and small scale photography from high altitudes could serve as a basis for study on a time basis of the actual phenomenology surrounding the building of missile sites, test facilities and the like. At the same time were companion pictures at sufficiently small scales (that is actual satellite scales) taken, we would see if what or how much of what we learn on the large scale photography can be seen at all on the small scale photography. The letter was a lengthy one, containing elaborations, details, suggested targets and suggested instrumentation.

The history of this idea and this letter is unfortunately quite common. The problem described in the letter is simply not a sexy problem. This doesn't mean its not important or that it doesn't have to be done but it just simply cannot compete in terms of glamour with many other kinds of problems and activities that BMD and in particular the 117L office is engaged in. Nevertheless Major Conway of that office gave it a good old try. He tried to get SAC to fly this photography for him, but the answer came back that SAC was disbanding its recce force and besides they were quite busy and besides this was nonroutine etc. etc. etc. This status was arrived at after about six months of negotiation. Conway then tried to get TAC recce to do the job but for some odd reason they were busy, what with I have never been able to find out. There seems to be a lot of reorganization, compliance with directives, stand downs, inspections and other things going on which soak up time

and make actual and interesting operations of this sort impossible.

In the meantime, and because we don't care who picks up a good idea I tried selling this notion to the Rome Air Development Center which in fact was very interested. At this time the usual business with getting flight tests off on a systematic basis sets in. These people who have never had anything to do with running a flight test program cannot believe what an impossible job it really is. It didn't get done, and is still not underway.

Last October, while working on the pre-Geneva homework in Washington, I brought this matter up to Colonel Bob Smith, Director of Intelligence at Headquarters SAC. He seemed enthusiastic; I promised to send him the 1956 letter plus supplementary updating material when he got back from Geneva. He expressed considerable interest in this mission and claimed SAC would certainly do this job etc. etc. etc. January 27 of this year I sent him the 1956 letter and some further information. I heard from Smith on March 3, 1959. His letter conveys an impression that "things are going on that are relevant" he further thinks this is really the job of BMD, but expressed considerable interest in seeing that this job gets done, recognizing its importance and so on.

Unfortunately there seems to be just enough token efforts of varied character, irrelevant and miniscule though they may be, to prevent me from making a flat all out statement that absolutely nothing is going on. Thus, these efforts that are going on, and that appear to some people to be relevant (though they do not so appear to me) are worse than useless: they prevent the recognition of the horrible vacuum that actually exists. My latest effort in this connection is to try to get the Aerial Reconnaissance Laboratory at Wright Field interested in this job. This may prove successful for two reasons. One, this laboratory has about 600 people, and is not really connected with any major reconnaissance program. They are hungry, they are eager, they are looking for work. So certainly the boundary conditions appear correct.

On the other hand if I were asked to bet as to whether a sensible program would be mounted, I would bet against it. It is because of numerous experiences such as this that I take some of the dim views that I am accused of having about the probability of our finding missiles sites in the Soviet Union etc.

5. Recommendation to BMD for Change of Camera Type in the 117L As is certainly known to most people who have heard me talk about the characteristics of the 117L camera system, it is based on a continuous strip camera. This is a camera in which film is pulled past a narrow slit in a focal plane in synchronous speed with the image speed produced by the forward motion of the satellite. There are a lot of reasons why we take a dim view of this particular kind of camera in that particular kind of environment. These reasons are summarized in D(L)-5203 dated 21 May 1958, entitled "Quick Fix: A New Camera for the 117L." This proposal for a new type camera 117L was communicated in L-11227 of 10 June 1958 to Colonel Fritz Oder, then Chief of the WS-117L Project Office at BMD.

It is not necessary to repeat the contents of either the letter or the document in this brief note except to indicate [redacted] of reasons we foresaw for thinking

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of changing camera type have finally appealed to the Project Office. It is my current understanding that "efforts and studies" are now under way by Eastman Kodak through a subcontractor whose name I don't have, to investigate the fessibility, practicality, desirability of this notion.

I might add that this kind of camera operation, the single frame system, instead of the continuous strip system is a necessary condition for successful mapping (on which more below) and also is a necessary requirement for the weather satellite suggestion which is also discussed later in this memo.

6. The Problem of Timeliness for the Talk-Back Satellite As noted earlier in this memo our views on the relation between talk-back satellites, which communicate their information by video link, and the more short-lived spit-back satellites which return their data physically to earth, have been expounded at great length and many times. In short, if the video talk-back satellite is to make sense at all it should use its limited data gathering capability for selected targets requiring repeated surveillance on a cyclic basis. In order for this mission to make much sense the time between observation of the data, whatever it may be, and the time when this data is piped back to earth must be reduced to a minimum, consistent with the observations being secured and the use to which they will be put.

While it is abundantly clear that in the absence of any satellite capability all such considerations are speculative and hypothetical and whatever examples may be adduced are essentially contrived, it is nonetheless equally clear that the timeliness characteristics built into the current 117L program are unsatisfactory. A brief word about this is in order.

In order to appreciate the remarks about 117L system which follow it must be remembered that at the time this system was dreamed up, specified, approved, and work started, there was no competing idea of other recce satellite system at hand. Inasmuch as we are not in the habit of doing reconnaissance on any massive basis over the Soviet Union it would seem hard to criticize a system which had a built-in delay of the order of a dozen hours. Stated more simply, if we waited years to see the pictures, we might as well wait another 12 hours.

Here's how and why a 12 hour average time delay happens with the 117L talk-back system. There are several boundary conditions on the operation of this system. First, for the case of the six inch focal length system originally proposed, and worked on as the phase one focal system (ARPA has ordered this one striken from the system), the camera takes pictures at the rate of 6 inches of film per minute. It is over the Soviet Union area for roughly one hour per day. On the other hand, for certain engineering reasons, power consumption, smoothing and so on the film processor was programmed to operate for 24 hours a day. Thus the processor would be operating much more slowly than would the camera taking the film. Since the film is all connected it is clear that there are certain storage loops that would be formed and would be required. The read-out mechanism works at the same speed as the camera does and reads out and transmits during the time the satellite is in view of the three ground receiving stations located in northeast, northwest and

central United States. Without seeing the exact nature of the read-out pattern and the delays which ensue, it should be clear to the reader that complications arise. In fact, it turns out that the average time delay between when data is taken over the Soviet Union and is read out over the United States is of the order of 10 to 12 hours.

Because quite some time ago we were able here at RAND to foresee the eventual triumph of the notion of recoverability and the change in the role of the video talk-back machine forced on it by the imminence of recoverability, we started thinking about the time delay problem. Last summer Mert Davies and I visited the Eastman Kodak Company in Rochester to discuss this and related problems. The head of the Eastman Kodak team is Dr. Kenneth Mcleish, a very able man. He told us two important things. First, this particular problem of increasing the timeliness characteristic of the system, that is cutting down the time delays had never been called to his attention (in fact, the Lockheed project officer who was present at the time was simply uninterested in our remarks, and said that he couldn't understand why in the devil anyone should be interested in cutting down the time delays of the talk-back system). After extensive discussion with Mcleish, he saw the light and noted that certain things were feasible that had not been contemplated simply because the requirement for cutting down time delays was not emphasized.

At the next meeting of the 117L advisory committee held in RAND's Washington office late last fall some of the BMD people announced, with considerable pride of achievement, that the previous criticism by Katz et. al. of the timeliness characteristic of the 117L system was being worked on, and that Mcleish of Kodak had some excellent ideas of what to do and how to do it. Score another one for the home team.

For whatever reason and certainly whatever reason there is escapes me, it appears that quite a few people seem incapable of entertaining more than one thought at a time. While we have been sincere in vocal advocates of the recoverable satellite idea we have never hesitated to point out the proper, logical, complementary and necessary role of the long-lived talk-back system, a role which takes on added stature when its jobs are determined by results secured from the recovery system.

7. The Mapping Satellite In RM-2179, written in mid '58 for General Ferguson's use we described the characteristics that a mapping system ought to have. At this precise time BMD and the 117L office was very loud in its advocacy of the notion that excellent maps could be made from the rubbery photographs produced by the strip camera in the 117L system.

By dint of additional talking to the Air Force requirements team by Davies and Katz, and this team's careful reading of our RM-2179, there soon appeared an addendum to GOR80 (covering the reconnaissance satellite system). This was GOR80-4 which covered the requirements for mapping and called out in almost precisely our language the basic ideas of RM-2179. In the meantime BMD was still arguing on the opposite kick that the 117L system was still the best one and much correspondence between them and AFDRQ ensued.

In fact another organization at BMD, one that had nothing to do with 117L, soon began to visit us here at RAND discussing the possibilities of mapping from satellites. We now believe that this BMD group were on an all together different kick - trying to justify extremely large payloads and man in space etc. They seized upon mapping as an understandable and valuable military function which could help sell their large payload argument.

Now although we are for mapping we do not insist nor do we believe that this system requires a large payload. All it requires is an excellent distortionless mapping camera of almost conventional variety taking pictures from a stabilized platform (which 117L promises us any day now) and with recovery of the film to prevent distortions in the read-out and transmission process (a TV set is a poor way to show a map).

At the latest design review meeting of the data handling system, held in Denver at the RW facility not long ago and attended by about 200 Air Force people, the 117L people announced that a recoverable mapping system is now under way as part of their program. The fact that I was in the audience and appeared properly stunned to find this victory announced publicly brought forth the comment from the 117L people that they never really opposed this idea and they had it in mind all the time. But this one I believe is a very clear cut follow-up to the work started with RM-2179. Rack up another marker.

8. An Air Force Cloud Reconnaissance System It occurred to me not long ago that the Air Force has defaulted on a function which could be logically described in terms of requirements to meet Air Force missions - that of providing cloud cover reconnaissance data for use in programming recce satellites, special reconnaissance missions, SAC refueling, and similar operations. Our work on this subject is described in two D's. D-6243 titled "An Air Force Weather Satellite - Why and How," dated 31 March 1959 and D-6242, "An Air Force Weather Satellite Utilizing TV," dated 6 April 1959, (the latter D is by John Huntzicker). We seem to have talked Colonel Dyer of AFDRQ into the sense, urgency, and feasibility of getting a satellite to meet this requirement by simple modifications of 117L and have gone so far as to write GOR80-5 as a suggested GOR for his use. To round out the bill of particulars here submitted this work will result in a formal RAND recommendation.

Summary I have written all the foregoing almost as much for my own information and record as for that of the addressees. It appears that if indeed we adopt the time scale of a geologist we can really see progress happening. The next trick is to get the Soviets to adopt this same time scale.

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